PLATE WASTE IN ELEMENTARY-SCHOOL LUNCHES: A FOCUS ON FOOD PAIRINGS, SHORTFALL NUTRIENTS, POTATOES AND SODIUM

A Thesis

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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December 2014

Major Subject: Nutrition

ABSTRACT

Elementary-school students have been found to waste a large amount of food served to them at school while consuming items high in sodium. This has led to decreased intake of calories, and the shortfall nutrients, fiber, potassium and calcium. There are many potential solutions to this problem including appropriate pairing of entrée and vegetable and providing items that are well accepted and naturally low in sodium. Plate waste studies were conducted to analyze waste, consumption, nutrient intake, and nutrient loss in elementary-school lunches based on the entrée and vegetable selection. Pairing of the entrée and vegetable was analyzed, as well as consumption of the different vegetable products and their associated intake of calories and three of the shortfall nutrients, fiber, potassium, and calcium.

The research found that there is an association between entrée and vegetable pairing. Four of these pairings provided over 1000 milligrams of sodium. Potato products provided the highest average amount of calories at an average of 65.7, as well as the high average amount of calcium at 31.45 milligrams. Average waste for potato products was under 70% for each type of potato product, with tater tots having the lowest average amount of waste.

This data could be used to assist in school menu preparation that might decrease waste in elementary school lunches, as well as increase consumption of crucial micronutrients potassium and calcium, as well as calories and fiber. This data can also

be used to analyze which items are high in sodium in order to reduce the consumption of sodium.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Murano, and my committee members, Dr. Ishdorj and Dr. Kubena, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience. I also owe thanks to my family for their constant support and encouragement throughout my studies.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

1. INTRODUCTION

In 2012, the United States Department of Agriculture and the Food and Nutrition Services announced a set of regulations that would be implemented to coordinate the National School Breakfast (NSBP) and Lunch Programs (NSLP) with the Dietary Guidelines for Americans. The research presented in this thesis focuses on plate waste in elementary school lunches. Plate waste was collected from the entrée and vegetable. The vegetable plate was analyzed for consumption and nutrients lost and consumed.

The NSLP is an essential program in that it provides lunches each day to more than thirty-one million children, but there are aspects of the program that could be changed to improve the nutrient quality of the lunches.[1] Sodium has been found to be in excess in the diets of elementary-aged children, whereas potassium intake has been found to be inadequate. Vegetable waste will be analyzed to determine the amount of sodium and potassium consumed. Potatoes are found to be naturally low in sodium and high in potassium, which may serve as a potential solution to the high sodium intake and low potassium intake. Children tend to waste large amounts of food but potatoes are a popular food product that when prepared in an appealing manner, could increase consumption.

This research will focus on four areas including entrée and vegetable pairings, sodium and potassium consumption, potato product consumption and the shortfall nutrients fiber, calcium, and potassium. Nutrients lost versus nutrients that could have been consumed will be determined for the different potato products including French

fries, tater tots, potato wedges, and mashed potatoes. Intake for calories and "short-fall" nutrients, fiber, potassium, and calcium will be determined. Plate waste from different pairings of vegetables and entrees will be observed to determine the desirable combinations to decrease plate waste. The waste versus consumption for sodium and potassium will be determined for the entrée and vegetable at each meal.

2. LITERATURE REVIEW

2.1 Health in Children

Healthy eating and physical activity are important factors in health promotion and disease prevention in children. These two factors assist in normal growth and development, cognition, and reduce the risk of health problems in the future. One large problem our country faces is the childhood obesity epidemic. The Task Force on Childhood Obesity by the White House has aims to create a healthy lifestyle for children beginning at pregnancy and continuing through early childhood. They desire to do this by empowering parents and caregivers with knowledge to make healthy choices, ensuring access to affordable, healthy food, and by serving healthier foods in schools.[1] The National School Lunch Program, which is discussed below, has the ability to affect the healthy eating factor. Healthy eating habits formed in childhood are essential for the prevention of obesity. Vegetable consumption can also play an important role in the NSLP. Vegetable consumption has been shown to prevent obesity through many factors. Increased consumption of vegetables can reduce energy density and decrease energy intake as well as promote satiety.[2] The intake of fruits and vegetables has also been shown to have an inverse association with the risk of stroke, intracerebral hemorrhage, and cerebral infarction.[3] Building healthy habits is essential at a young age, as these habits can potentially be carried throughout life and can prevent many health issues later in life such as obesity, diabetes, and heart disease.

2.2 National School Lunch Program

The National School Lunch Program is a federally regulated program that provides nutritionally balanced lunches to around 31 million students per day. This program provides opportunities for fruit, vegetable, whole grain, and dairy consumption. The schools participating in the program must meet nutrition standards set by the Dietary Guidelines for Americans. Calorie limits are set to ensure age-appropriate are served to children from kindergarten through fifth grade, sixth grade through eighth grade, and ninth grade through twelfth grade. There is currently a sodium reduction timeline in place with hopes of reducing the current sodium allowance of 1230 milligrams per meal to 640 milligrams per meal by 2022.[4] The new Healthy Hunger-Free Kids Act (HHFKA) has a guideline for sodium to be set at 640 milligrams.[5] Only 10% of elementary-school children currently meet the HHFKA guideline.[6]

The new school meal standards were implemented at the beginning of the 2012-2013 school year. Our study was conducted in the spring of 2012 and fall of 2012 therefore the first data set was collected during the old standards and the new data set collected during the new standards. Table 1 compares the previous school meal standards with the new standards for fruits, vegetables, whole grains, and milk.[7]

Table 1. Comparison of Previous and Current School Meal Standards

Food Group	Previous Standards	Current Standards
Fruit and Vegetables	½ - ¾ cup of fruit and vegetables combined per day	¾ cup of vegetables AND ½ -1 cup of fruit per day
Vegetables	No specifications	Requirements weekly for subgroups (dark green, red/orange, starchy, legumes, and other)
Whole Grains	No specifications – encouraged	Half of the grains served must be whole grains starting July 1, 2012. All grains served must be whole grains starting July 1, 2014.
Milk	1 cup No restrictions on flavor or fat content.	1 cup Must be fat-free/low fat for flavored and unflavored OR 1% low fat if unflavored

Offer vs. Serve (OVS) must be followed and is shown in Table 2. OVS requires that students select 3 out of 5 of the components served at school lunch. These 5 items are the entrée, fruit, vegetable, grain, and milk. OVS requires that a reimbursable meal must contain a fruit or a vegetable.[5] The following table explains the properties of OVS[8]:

Table 2. Offer Versus Serve Before and After HHFKA Initiation

Properties of OVS	**Prior to HHFKA**	**HHFKA**
Implementation	Mandatory at high school level Optional at middle school and elementary school level	No change
Reimbursable Meals	Meals must off four of five food components to qualify	Meal must offer five food components
Number of selections for OVS	Three items must be selected at high school level Three or four items must be selected for lower levels.	Three items must be selected with one being ½ cup of vegetable or fruit.

These standards have been implemented to improve the nutritional quality of the diet of the school children as well as to reduce food waste and costs by allowing children to select items they enjoy and will consume.

A study by Cohen at Harvard School of Public Health analyzed the impact of the new school meal standards on consumption and waste in elementary schools. Implementation of the new standards led to a significant increase in fruit selection from 52.7% of children selecting fruit to 75.7% of children selecting fruit. Although there was an increase in the number of children selecting fruit, there was not a significant difference in the quantity of fruit consumed. Selection of milk significantly decreased from 79.8% selecting milk to 55.1% selecting milk. When analyzing actual consumption

pre- and post-implementation, vegetable consumption significantly increased from 24.9% to 41.1%. If analyzing consumption in cups, vegetable consumption increased from 0.13 cups pre-implementation to 0.31 cups post-implementation. Entree consumption also significantly increased from 72.3% pre-implementation to 87.9% post-implementation.[9]

The School Nutrition Dietary Assessment III (SNDA-III) is a survey taken that is based on a nationally representative sample of children grades 1 through 12 in 130 public school food authorities in the United States. According to the SNDA-III participants in the NSLP consumed greater amounts of vitamin B-12, vitamin A, protein, calcium, phosphorus, riboflavin, and potassium than those students who consumed a lunch brought from home. Nonparticipants were more likely to consume snack foods, desserts, and carbonated soft drinks than participants.[10] Using the SNDA-III, researchers found that school lunch participants were significantly more likely to consume fruit, vegetables, and milk than nonparticipants. An average of 20% of participants consumed canned fruit whereas only 6% of nonparticipants consumed canned fruit. An average of 30% of participants consumed vegetables (except French fries) whereas only 11% of nonparticipants consumed vegetables. Seventy-five percent of participants consumed milk whereas only 19% of nonparticipants consumed milk. All of the previous differences in levels of consumption were significant at the $P<0.01$ level.[11]

A study using the SNDA-III to assess nutritional quality of school lunches found 92% of public school children in the United States had intakes of sodium higher than the Tolerable Upper Intake Level. Based on a 24-hour energy and nutrient intake survey,

children consume an average of 3402 milligrams of sodium per day and only 2499 milligrams of potassium per day. Mean intakes of potassium were equivalent to 57% of the Adequate Intake (AI) and mean intakes of fiber were equivalent to 49.3% of the AI. Children also consumed in an inadequate amount of fiber at only 14.1 grams per day. When matched with nonparticipants, it was found that NSLP participants had significantly higher mean intakes of calcium for middle-school and high-school students. These age groups also had significantly higher mean intakes of potassium. At all three grade levels NSLP participants had significantly higher mean intakes of fiber.[12] While participation in school meal programs is found to be associated with excessive sodium intakes, it is also associated with an increased probability of adequate vitamin and mineral intakes compared to nonparticipants.

2.3 Plate Waste

Many different techniques can be used to measure intake such as dietary recalls, visual estimation, and physical measurement of the food consumed. This physical measurement is employed in plate waste studies. These types of studies have been found to provide the most accurate data when measuring intake.[13,14] A study was completed to assess plate waste studies as a way to measure intake in children. Items were pre-weighed to determine the amount being served and a station with large pre-weight garbage tubs was established. Children were asked to scrape their waste into the appropriate bin. At the end of the lunch period the tubs were weighed and the weight of

the tub was subtracted to determine the weight of the waste. Previous studies have employed similar methods, but this study also took individual measurements. Each item was weighed before the children entered the cafeteria and at the end of the lunch period children were at random to leave their tray on a separate table and researchers weighed the items left on their plate and determined actual intake using the initial weights. The individual data sets were averages and compared to an earlier study that employed the use of the aggregate selective plate waste method. When comparing the data from the individual measurements to the aggregate plate waste method, energy intake and macronutrient intake was not statistically different. The number of servings of fruits and vegetables consumed also was not statistically different between the two methods. This study confirms that the aggregate plate waste method is a simpler, yet valid method for collecting waste and determining consumption as the individual method.[15]

A recent study of elementary-school students participating in the US National School Lunch Program found that these students wasted 33.6% of vegetable menu items. A similar percentage of waste was found for the grain and fruit menu items. Students in the fourth and fifth grade tend to waste one-third to one-half less than the first and second grade students for each menu item. First grade students wasted an average of 47.8% of their vegetables whereas fifth grade students wasted an average of 16.5% of their vegetables.[6]

Food waste was observed in prekindergarten and kindergarten students after the implementation of the new lunch program guidelines. The new guidelines NSLP guidelines require that school lunches provide five components – vegetable, fruit, whole

grains, protein, and low-fat dairy. They require that the student must take a fruit or a vegetable each day. There are also weekly requirements for red/orange, dark green, starchy, beans/pea, and other vegetables.[10] The researchers found that the highest amount of waste, 51.4%, was from the vegetable item, but the daily waste range was 26.1% to 80.1%. The research team found that of the 139.8 cups of vegetables served, 92.6 cups of vegetables were wasted. The entrée was associated with the second highest amount of waste at 51% followed by milk at 45.4%. An average of 33% of the fruit items were wasted.[17]

Nutrients consumed and costs were analyzed in a recent study of middle school lunches. This study included two control schools and two Chef Initiative schools which had trained professional cafeteria staff chefs to make healthier meals. It was found that only 50% of calories in the lunches were consumed on average in both of the schools. In the Chef Initiative schools students consumed only 50% of the target amount of fiber, and in the control schools the students consumed less than 33% of the target amount. In both schools students wasted approximately 19% of their entrées, 73% of their vegetable, 47% of their fruit, and 25% of their milk. Federal lunch requirements are set at 370 milligrams of calcium. An average of 528 milligrams were served and only 304 milligrams were actually consumed. Based on the current trends of food waste, the waste cost annually averages $432,349.50 worth of food.[18]

The standards for nutrients that are set for school meals are set with the assumption that all foods served are consumed. Therefore, with any amount of waste, minimum levels for consumption of nutrients may not be met.[19]

2.4 Sodium and Potassium

Excessive sodium intake can cause a number of issues for an individual. Renal sodium retention is the primary cause of secondary hypertension. The National Heart, Lung, and Blood Institute recommends that individuals should not consume more than 2400 milligrams of Na+ per day (6 grams of salt). For those individuals with hypertension or renal disease the recommendation is reduced to 1500 milligrams of Na+ per day.[20] The Dietary Reference Intake (DRI) values have set an Adequate Intake (AI) for both sodium and potassium for various age groups. Children between the ages of four and eight have an AI set at 1.2 grams per day for sodium and 3.8 grams per day for potassium. Children between the ages of nine and thirteen have an AI set at 1.5 grams per day for sodium and 4.5 grams per day for potassium.[21] The World Health Organization (WHO) recommends an increase in potassium through food for children to control blood pressure, because it has been found that children with high intakes of potassium have a smaller increase in systolic blood pressure annually.[22,23] WHO also recommends a decrease in the intake of sodium in children to control blood pressure.[24]

The third School Nutrition Dietary Assessment Study (SNDA-III) found that elementary school children have an average intake of 3320 ± 67.1 milligrams of sodium and only 2518 ± 42.9 milligrams of potassium. National School Lunch Program participants were matched to nonparticipants, and participants were found to have approximately 200 milligrams more sodium at lunch.[12]

2.5 Potatoes

Although previous studies have shown potato consumption to be associated with high intakes of sodium, the potato is naturally low in sodium. Proper preparation of this item with little added sodium could make this item a potential solution to the excessive intake of sodium in school lunches.

Previous research has shown that French fried potatoes are among the most frequently consumed vegetables, and according to the 2003-2006 National Health and Nutrition Examination Survey (NHANES) for children in the United States between the ages of two and eighteen, white potatoes are the number three source of potassium.[25] The USDA Nutrient Data Laboratory states that one cup of a white potato with the skin has 610 milligrams of potassium and only 24 milligrams of sodium. One cup of potato also has negligible fat (0.15 grams) and provides 104 calories.[26]

A study on white potatoes found that white potatoes, oven-baked fries, and French fries provide shortfall nutrients in the diets of children.[27] Using NHANES 2003-2006 data, the researchers found that the combination of white potatoes (WP), oven-baked fries (OBF), and French fries (FF) as well a French fries by themselves provided approximately 9 to 12% of total energy while providing over 10% of dietary fiber and potassium and less than 5% of sodium intake. Male children (ages 2-13) who consumed WP, OBF, and FF consumed approximately 13.6 grams of fiber per day from those items and female children who consumed WP, OBF, and FF consumed approximately 12.3 grams of fiber per day from those items. Adolescent males (ages 14-18) who consumed

the previous items received an average of 15.7 grams of fiber per day from them and adolescent females received an average of 11.7 grams of fiber per day from them. Consumption of WP, OBF, and FF was associated with an intake of an average of 981 milligrams of calcium per day in male children and 899 milligrams per day in female children. In adolescents those items were associated with an average intake of 1180 milligrams of calcium per day in males and 764 milligrams of calcium per day in females. These same items were associated with an intake of 2509 milligrams of potassium per day in male children and 2332 milligrams in female children. In adolescents, these items were associated with an average intake of 3183 milligrams of potassium per day in males and 2183 milligrams in females. While the previous intake of nutrients has provided adequate amounts of nutrients, sodium consumption is excessive when WP, OBF, and FF are consumed. In male children, they are associated with an average intake of 2949 milligrams of sodium per day, and in female children they are associated with an average intake of 2734 milligrams of sodium per day. These intake values increase in adolescence, with males consuming an average of 4487 milligrams of sodium per day and females consuming an average of 3064 milligrams of sodium per day.[27]

Cost plays an important role in choosing foods for school lunches. White potatoes, French fried potatoes, and sweet potatoes are the lowest-cost vegetable items along with beans and carrots.[28] In a raw potato there is approximately 564 milligrams of potassium per gram of fresh weight, which provides 22% of the RDA for potassium.[29] For potatoes, the median cost for 10% of the daily value for potassium is $0.14.

According to previous research, white potatoes combine consumer acceptance, affordability, and nutrient density.[28] Lipids comprise a minute fraction of potato weight at 0.15 grams per 150 grams fresh weight.[29] Not only are white potatoes low in fat and sodium, they are also low in cost. White potatoes have the potential to be a healthy, cost-effective alternative to other vegetables that contain added sodium.

2.6 Shortfall Nutrients

Many children between the ages of 2 and 11 consume inadequate amount of certain nutrients which leads them to be considered shortfall nutrients. Nutrients included in this group are fiber, calcium, vitamin D, and potassium.[30]

Intake of fiber is associated with a variety of health benefits. The AI of fiber is set at 14 grams per 1000 kilocalories due to its protection against cardiovascular disease at this level. It has been suggested that adequate fiber intake is associated with a decreased risk of cardiovascular disease and coronary heart disease.[31,32,33] Consumption of adequate amounts of fiber has also been shown to prevent weight gain and attenuate glucose absorption weight which may help to prevent diabetes.[34] Fiber intake is also associated with improved insulin sensitivity and increased satiety due to bulk which can assist with weight loss.[34,35] It is recommended that high-fiber foods such as whole grains, legumes, fruits, and vegetables be consumed regularly.[34]

The Adequate Intake (AI) for fiber is set at 25 grams for children ages 4-8 and 31 grams for males ages 9-13 and 26 for females ages 9-13.[36] Fiber intakes have been found

to range from 10 to 12 grams/day for girls and 11 to 14 grams/day for boys.[37] Nationally representative data from NHANES 2003-2006 found that the top sources of fiber for children between the ages of 2 and 18 were fruit and yeast breads/rolls.[26]

Not only is calcium an intracellular messenger which is essential in signal transduction it is also a cofactor for proteins and extracellular enzymes. It is necessary for blood clotting enzymes and for certain proteases. The weight of bone mineral in the body is 39.9% calcium. Calcium is essential for protection against osteoporosis later in life.[31] The USDA currently has the Recommended Dietary Allowance (RDA) for calcium set at 1000 milligrams for children ages 4-8 and 1300 milligrams for children ages 9-13.[22] NHANES 2005-2006 found that 15% of females ages 9 to 13 had adequate consumption of calcium.[38] Calcium is essential for proper bone development. A studying using data from the third NHANES showed that in females, low intake of milk as a child led to low bone density as an adult leading to a greater risk of fracture.[39] NHANES 2003-2006 found milk and cheese to be the top sources of calcium for children between the ages of 2 and 18 years.[26]

Potassium is known for its functions in cardiac conduction and rhythm, as well as for its functional alterations in multiple organs. Dietary potassium has been shown to increase the excretion of sodium when the sodium intake is highest, but an effect can still be seen at a sodium intake of 1.6 grams. This data shows that increased potassium intake could assist in lowering blood pressure through the excretion of sodium.[31] The AI for potassium is set at 3.8 milligrams for children ages 4-8 and 4.5 milligrams for children ages 9-13.[22] NHANES 2009-2012 found that the mean intake of potassium for 2

to 5 year old children was 2071 milligrams and mean intake of potassium for 6 to 11 year old children was 2172 milligrams. Both of these averages fall below the AI value for these children.[40] Based on NHANES 2003-2006, the top sources of potassium for children between the ages of 2 and 18 are milk and fruit juice.[26]

2.7 Food Pairings

While many plate waste studies have been conducted in schools, none have observed the relationship between the pairing of foods. Currently this topic has very minimal literature published therefore observing the relationship between the pairing of the entrée and vegetable will be contributing new research to the field of nutrition. A website entitled foodpairing.com has researched and found and way to identify food and ingredient pairings. It is thought that if the pairings have the same major volatile molecules, then they may taste and smell appealing when consumed together.[41] With a desirable food pairing of entrée and vegetable, waste could be decreased in the elementary-school lunch setting.

2.8 Barriers to Consumption

Many different factors can be barriers to consumption in school lunches. Preparation method and competitive foods are two of those factors. For example, whole apple waste was 62% whereas applesauce waste was only 23%. Competitive food items

such as cookies, potato and corn chips, popcorn, sports drinks, and fruit flavored drinks decreased consumption of food items. Those who purchased competitive foods wasted 52% of fruits whereas the students who did not purchase competitive foods only wasted 36%. Mixed dishes such as casseroles, pizza, and sandwiches had a waste percentage of 29.8% when competitive foods were purchased. Mixed dishes purchased without competitive foods only had a waste percentage of 18.3%.[42] In schools that had a policy of restricting snack availability children had significantly higher frequency of vegetable and fruit consumption.[43]

It has been shown that parental intake of fruits and vegetables directly correlate with their child's intake of fruits and vegetables.[44] A second study supports this same theory that maternal preferences correspond with the child's preferences. This also reveals that the foods a mother likes will be served to the child. This causes an issue with other foods not being served to the child leading to an unfamiliarity of those foods which in turn can lead to a decreased intake of those foods.[45]

Poelman, et. al. found familiarity and variety in the number of vegetables liked is associated with higher vegetable acceptance. Preparation methods of vegetables also had an effect on intake. Poelman's research found that baked and stir fried samples of cauliflower and beans were less accepted than boiled samples. Factors such as a browned flavor and high odor intensity tended to lower vegetable acceptance among five and six year olds.[46]

A preparation method study by Zeinstra et. al, conducted taste tests of carrots and French green beans prepared mashed, steamed, boiled, grilled, deep-fried, and stir-fried.

Participants significantly preferred steamed and boiled vegetables over other preparation methods. Granular texture and brown coloring was inversely related to vegetable liking. Children tended to enjoy vegetables that had the typical vegetable taste and a uniform surface.[47]

A different study on preparation method found that vegetable liking depends on a number of different factors including the type of vegetable and the method of preparation which can be different for each vegetable. Familiarity of the vegetable and neophobia also played a role in vegetable liking. Neophobia involves an avoidance of unfamiliar items because they are new to the individual.[48,49] Different characteristics of the vegetables such as sweetness, bitterness, brown coloring, and tough texture relate to vegetable liking.[49]

One method for potentially increasing children's intake of vegetables is to provide choices. Dominguez et. al. found that when offered with a choice of vegetable at the beginning of the meal or with two vegetable options throughout the meal, the child's vegetable was increased in comparison with when they were offered no choice.[50] Repeated taste exposure has also been shown to increase liking for vegetables. A recent study showed that repeated tastings of carrots, peas, and tomatoes increased the liking scores. For children who began the study not liking those vegetables, eight or nine taste exposures were required to change the child's response to "liking" or "liking a lot".[51]

3. RESEARCH OBJECTIVES

1) To determine if there is a relationship between entrée and vegetable pairing by observing the entrée and vegetable waste and consumption.
    a. Within the pairings, to determine sodium and potassium intake to discover which pairing provides lower amounts of sodium. Sodium and potassium consumption for the individual vegetables will be determined. The potato will be examined as a potential product to assist in reduction of the potentially high intake of sodium. The potato will also be examined as a potential product to increase the potentially low intake of potassium.

2) To determine if potatoes contribute to improved nutrient intake in elementary-school students in regards to calories and two of the four shortfall nutrients, fiber and calcium. Data was not available for the shortfall nutrient vitamin D and the shortfall nutrient potassium is analyzed in the previous objective.
    a. The waste for different methods of preparation of potatoes will be analyzed to determine the method for potato preparation that is associated with the least amount of waste.

4. RESEARCH HYPOTHESES

1) There is a relationship between entrée and vegetable pairing. This will be determined by observing the associated vegetable waste.
    a. Sodium consumption is over the recommended amounts for the pairings. Potato products will provide more potassium than other vegetables.

2) When potato products are served, children consume adequate amounts of calories and the two of the four shortfall nutrients, fiber and calcium.
    a. Among the different methods of potato preparation, potato wedges will have the highest amount of waste.

5. METHODOLOGY

Bryan Independent School District participated in the research. Each school selected was based on free or reduced-price school meal participation percentage and student enrollment. This data is shown in Table 1. Anson Jones Elementary, Mary Branch Elementary, and Sam Houston Elementary school participated. Plate Waste was collected on all students who received a school lunch that day from kindergarten through the fifth grade. Table 3 describes the percentage of students that receive a free or reduced-price lunch for each school.

Table 3. Percentage of Students on Free or Reduced-Price Lunch

School	Enrollment	Free Lunch (%)	Reduced Lunch (%)
Anson Jones	677	95.1	3.6
Mary Branch	601	69.1	4.8
Sam Houston	515	26.9	4.5

Table 4 describes the demographics of the three different schools.

Table 4. Demographics of the Different Schools

Schools	African American – Not of Hispanic Origin (%)	Hispanic (%)	White - Not of Hispanic Origin (%)	Asian (%)	Alaskan Native, Pacific Islander (%)	Multi-racial (%)
Bryan ISD (Phase 1)						
School A	20.6	76.6	2.5	0.0	0.0	0.3
School B	33.2	36.0	36.0	1.0	1.0	1.7
School C	9.7	9.7	20.1	0.4	0.2	1.2
Bryan ISD (Phase 2)						
School A	19.5	76.3	3.6	0.0	0.1	0.4
School B	37.2	42.5	27.7	0.7	0.0	2.0
School C	8.7	20.9	68.2	0.2	0.4	1.6

A total of thirty days of collections occurred. Phase 1 included ten days in Bryan ISD. Phase 2 included twenty days in Bryan ISD. Data collection occurred during the months of April and May of 2012 for Phase 1 and October and November of 2012 for Phase 2.

Plate waste is defined as the amount of food left after the meal that the students did not consume. Plate waste was both directly and indirectly measured. Direct measurements occurred by measuring the weight of the waste. Ten servings of each food

were pre-weighted to calculate an average weight of each item. The waste was then collected and weighed, and based on the number of children that selected that food item, an average waste per child was calculated. Indirect measurements were taken by photography and visual estimation of the percentage of the item consumed.[52]

The percentage waste was calculated by the following formula:

Percentage Waste = (Plate Waste of Food/Weight of Mean Serving Size) x 100

Children made their way through the lunch line. If the child selected one entrée and at least one vegetable, they received a specific color of sticky note on their tray that coded for the entrée. If the child did not select a vegetable, he or she received a "dummy" sticky note. The sticky note was color coded based on entrée. The child's grade and gender was written on the note as well as a coding for the vegetable he or she selected. Every tenth sticky note had a star on it, indicating that a picture must be taken of the tray before and after consumption. Once the students finished eating they were directed to the Plate Waste Warrior (PWW) with the coordinating color based on entrée. The PWW then scraped their entrée and vegetable into the appropriate bin. The sticky notes were collected as the trays were scraped. At the end of each lunch the waste bags were tied and separated in order to keep each grade separate. Each bag of waste was weighed and the weight of the bag was subtracted in order to have the weight of the food alone. The weight was then recorded and the average individual plate waste was determined by dividing the weight of the waste by the number of students who selected

that item. This was calculated for each grade from kindergarten through fifth grade. From this data, nutrient consumption and waste were determined.

Table 5 describes the study sample, including division by grade, sex, and date of the collection.

Table 5. Study Sample

	Bryan ISD (Spring 2012)	**Bryan ISD (Fall 2012)**	**Total**
Total Students in Sample	2849	4401	7250
Sex			
Male	1414	2233	3647
Female	1434	2168	3602
Grade			
Kindergarten	494	805	1299
First	565	658	1223
Second	475	844	1319
Third	424	743	1167
Fourth	434	752	1186
Fifth	457	599	1056

Bryan Independent School District provided information on nutrient content of the food items per serving size, meal counts, and menu calendar. This information will be used to answer the research questions.

6. STATISTICAL ANALYSIS

The statistical analysis used was a form of descriptive statistics. Comparison of means was used to determine if there was a relationship between entrée and vegetable pairing, to determine which items provide less sodium and more potassium, to determine if potatoes contribute to improved nutrient intake, and to determine which method of potato preparation is associated with the least amount of waste. This type of statistics was used because the data sample was group averages, not individual data for each student.

For Objective I, only vegetable waste was calculated because including entrée data would be misleading. Each meal the entrée was collected with two different vegetables, therefore the entrée waste would be the same for each of the different vegetables. If the entrée had been collected with each vegetable served, the entrée waste would have been used also in the calculations.

7. RESULTS

7.1 Objective I

The pairing of the entrée and vegetable was analyzed to determine the appropriate pairing to decrease the vegetable waste. Figure 1 results are separated based on vegetable.

Figure 1. Mean Broccoli Waste Based on Entrée Selection

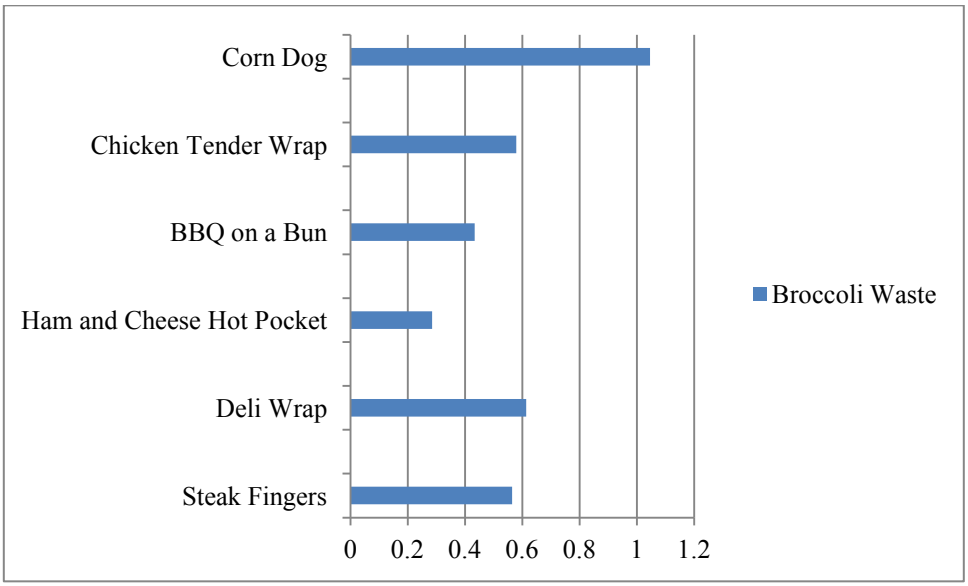


Table 6. Mean Broccoli Waste Based on Entrée Selection

Entrée	**Broccoli Waste**
Ham and Cheese Hot Pocket	28.47%
BBQ on a Bun	43.32%
Steak Fingers	56.38%
Chicken Tender Wrap	57.81%
Deli Wrap	61.27%
Corn Dog	104.52%

As shown in Table 6, when served with Corn Dogs, broccoli had the largest percentage of waste. Waste was over 100%, which could be due to serving sizes larger than the average or children sharing food leading to extra servings of corn dog on a plate. At 28.47% vegetable waste, Ham and Cheese Hot Pockets were associated with the least amount of waste for broccoli.

Figure 2 shows the mean green bean waste based on entrée selection.

Figure 2. Mean Green Bean Waste Based on Entrée Selection

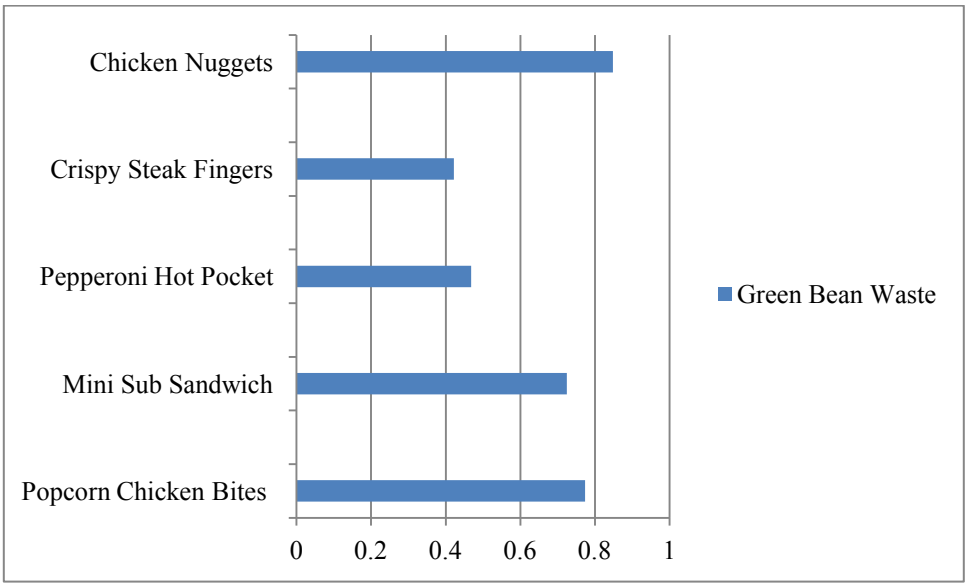


Table 7. Mean Green Bean Waste Based on Entrée Selection

Entrée	**Green Bean Waste**
Crispy Steak Fingers	42.22%
Pepperoni Hot Pocket	46.84%
Mini Sub Sandwich	72.45%
Popcorn Chicken Bites	77.36%
Chicken Nuggets	84.82%

As shown in Table 7, over 80% of green beans were wasted when served with chicken nuggets, whereas only 42.22% of green beans were wasted when served with crispy steak fingers.

Figure 3. Mean Mashed Potato Waste Based on Entrée Selection

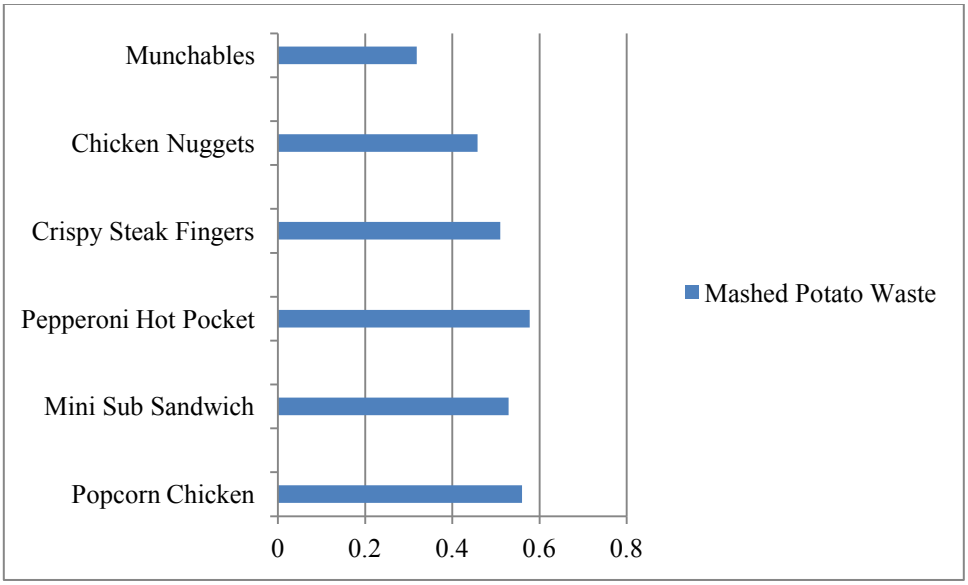


Table 8. Mean Mashed Potato Waste Based on Entrée Selection

Entrée	**Mashed Potato Waste**
Munchables	31.85%
Chicken Nuggets	45.75%
Crispy Steak Fingers	51.00%
Mini Sub Sandwich	52.88%
Popcorn Chicken	55.93%
Pepperoni Hot Pocket	57.72%

As shown in Figure 3, the mean mashed potato waste did not vary greatly between the different entrees.

As shown in Table 8, fifty-eight percent of mashed potatoes were wasted when served with Pepperoni Hot Pockets. Munchables (cheese, ham, and crackers) were associated with only 32% waste of mashed potatoes.

In Figure 4 the mean waste for French fries is shown.

Figure 4. Mean French Fries Waste Based on Entrée Selection

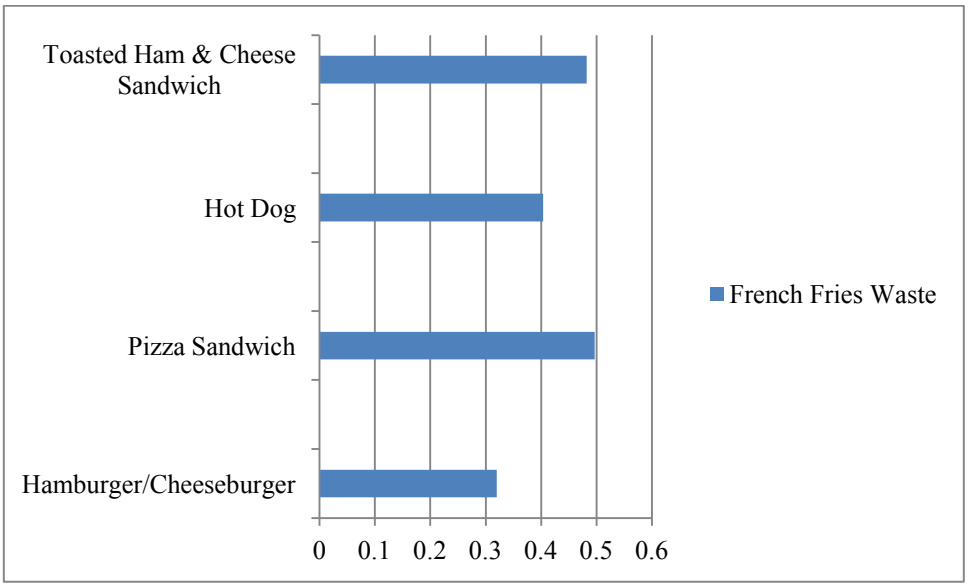


Table 9. Mean French Fries Waste Based on Entrée Selection

Entrée	French Fries Waste
Hamburger/Cheeseburger	31.98%
Hot Dog	40.37%
Toasted Ham & Cheese Sandwich	48.19%
Pizza Sandwich	49.63%

As show in Table 9, French fries had the least waste at 31.98% when served with hamburgers and cheeseburgers. Waste was increased to 49.63% when served with the pizza sandwich. Figure 5 shows the mean potato wedge waste based on entrée selection.

Figure 5. Mean Potato Wedge Waste Based on Entrée Selection

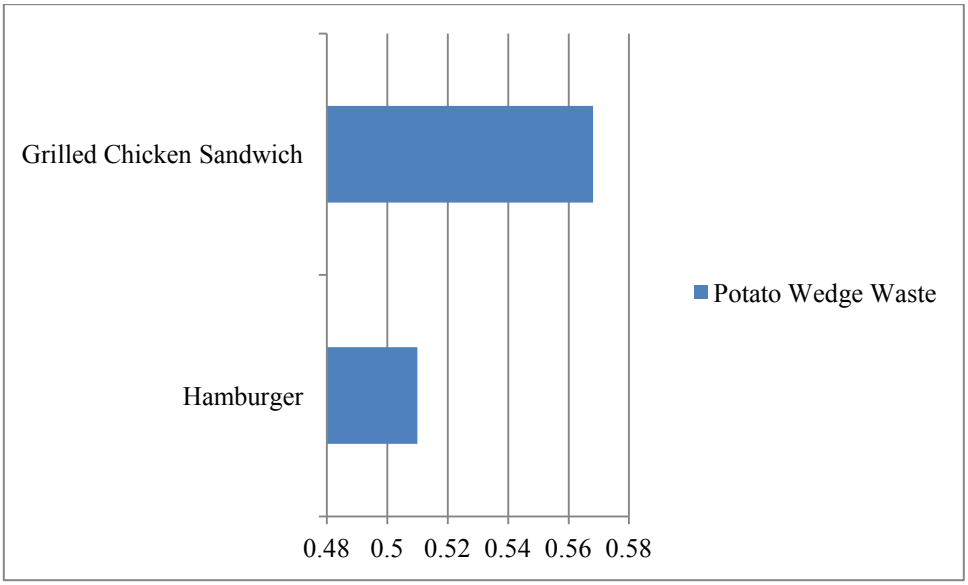


Table 10. Mean Potato Wedge Waste Based on Entrée Selection

Entrée	Potato Wedge Waste
Hamburger	51.00%
Grilled Chicken Sandwich	56.81%

As shown in Table 10, potato wedges were only served with two different entrees. When served with the hamburger, potato wedge waste was 51%. When served with the grilled chicken sandwich plate waste for potato wedges increased to 56.81%.

In Figure 6 the mean green pea waste depending on entrée selection is shown.

Figure 6. Mean Green Pea Waste Based on Entrée Selection

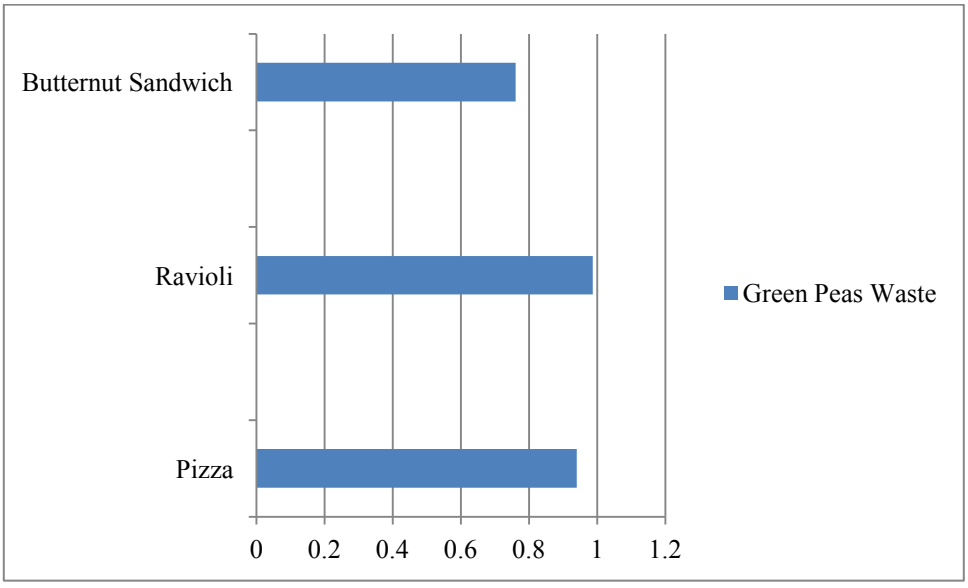


Table 11. Mean Green Pea Waste Based on Entrée Selection

Entrée	Green Pea Waste
Butternut Sandwich	76.08%
Pizza	94.03%
Ravioli	98.68%

Table 11 shows that each entrée that green peas were served with, the associated waste was over 70%. If served with ravioli, green pea waste was 98.68%. If served with pizza, green pea waste was 94.03%. Green pea waste was 76.08% when served with the Butternut Sandwich. Figure 8 shows that the mean corn on the cob waste was lowest when served with deli sliders and highest when served with the chicken tender wrap.

Figure 7. Mean Corn on the Cob Waste Based on Entrée Selection

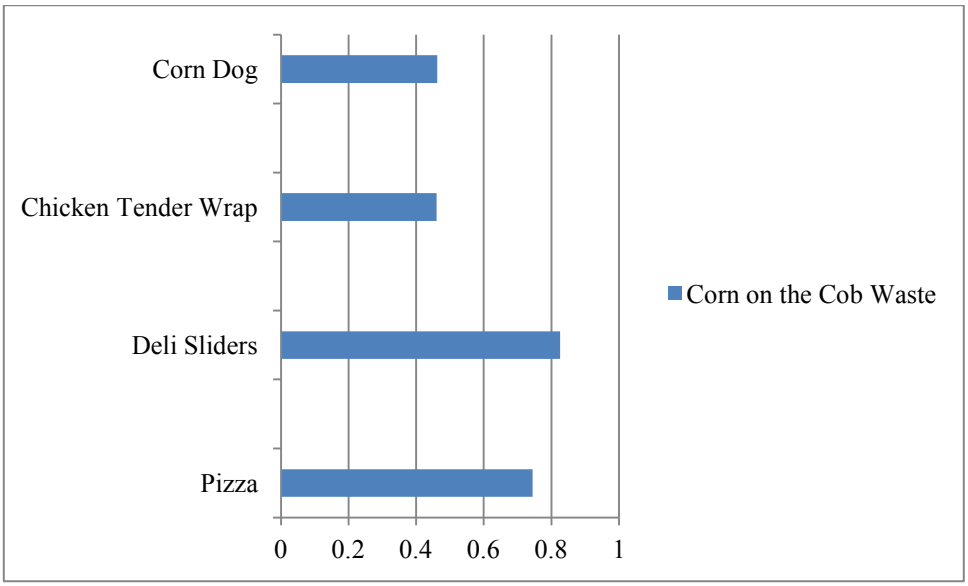


Table 12. Mean Corn on the Cob Waste Based on Entrée Selection

Entrée	Corn on the Cob Waste
Chicken Tender Wrap	46.03%
Corn Dog	46.20%
Pizza	74.47%
Deli Sliders	82.59%

In Table 12, corn on the Cob was analyzed separately from Whole Kernel Corn. An average of 82.59% of the Corn on the Cob was wasted when served with Deli Sliders. An average of 46.03% of Corn on the Cob was wasted when served with Chicken Tender Wraps.

Whole Kernel Corn mean waste in shown in Figure 8. Table 13 shows the exact percentage of waste of whole kernel corn with each entrée is was served with.

Figure 8. Mean Whole Kernel Corn Waste Based on Entrée

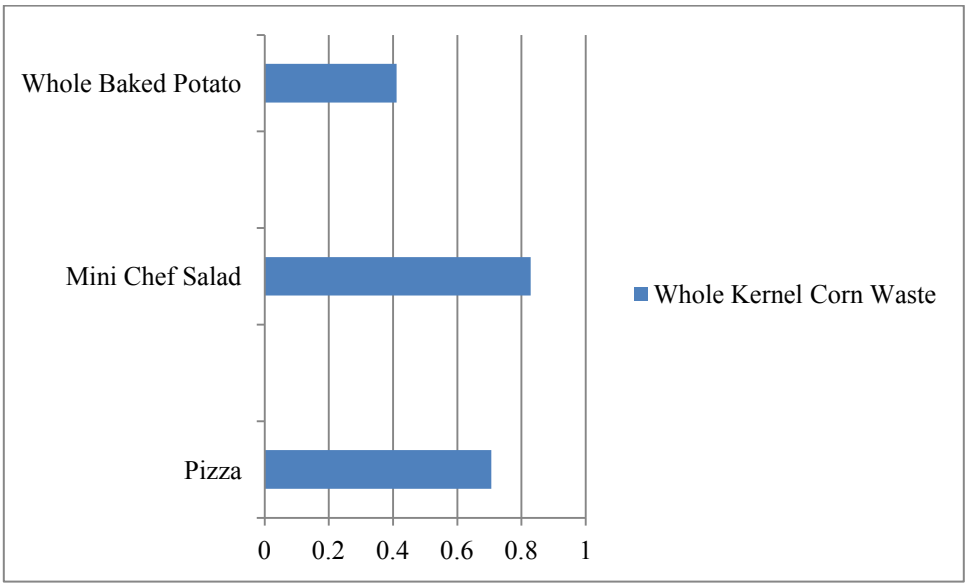


Table 13. Mean Whole Kernel Corn Waste Based on Entrée

Entrée	Whole Kernel Corn Waste
Whole Baked Potato	41.12%
Pizza	70.57%
Mini Chef Salad	82.82%

An average of 82.82% of Whole Kernel Corn was wasted when served with the Mini Chef Salad. An average of 41.12% of Whole Kernel Corn was wasted when served with a Whole Baked Potato.

The following pictures in Figure 9 represent the entrée and vegetable pairing that are associated with the least waste of the vegetable item. They are presented in order

from the vegetable item with the least average waste to the vegetable item with the most average waste within the top ten pairings associated with the least waste.

Figure 9. Top 10 Entrée and Vegetable Pairings Associated with the Least Waste

Ham and Cheese Hot Pocket
with Broccoli (28.47% waste)

Munchables
with Mashed Potatoes (no picture available)
(31.85% waste)

Figure 9. Continued

Hamburger/Cheeseburger
with French Fries (31.98% waste)

Hot Dog
with French Fries (40.37% waste)

Whole Baked Potato
with Whole Kernel Corn (41.14% waste)

Crispy Steak Fingers
with Green Beans (42.22% waste)

BBQ on a Bun
with Broccoli (43.32% waste)

Chicken Tenders
with Mashed Potatoes (45.75% waste)

Figure 9. Continued

Chicken Tender Wrap
with Corn on the Cob (46.03% waste)

Corn Dog
with Corn on the Cob (46.20% waste)

The pictures above are snapshots of potential combinations of school lunches. The entrees and vegetables pictured were the combinations associated with the least waste, but the other items selected were random and could potentially be different for each child. Table 14 details the nutrient profile for each of the trays pictured above. This nutrient profile will not be the same for each child, depending on what the child selected, but provides an example of school meals.

Table 14. Nutrient Profile of School Meals Pictured Above

Meal	Calories	Fat (g)	Protein (g)	Fiber (g)	Sodium (mg)
Ham & Cheese Hot Pocket with Broccoli	802	18.6	33	9.9	1647
Munchables with Mashed Potatoes	551	13.9	35.4	5.5	1708
Cheeseburger with French Fries	637	15.9	34.1	6.7	1169
Hot Dog with French Fries	560	19.9	21.2	5.3	1078
Whole Baked Potato with Cheese Sauce with Whole Kernel Corn	791	12.9	33.9	14.5	1312
Crispy Steak Fingers with Green Beans	723	24.7	30.8	11.4	1818
BBQ on a Bunch with Corn on the Cob	650	11.1	27.7	10.8	970
Chicken Tenders with Mashed Potatoes	473	18.4	20.3	4.6	963
Chicken Tender Wrap with Corn on the Cob	669	30.3	22.8	8.8	887
Corn Dog with Corn on the Cob	645	17.3	22	9.4	899

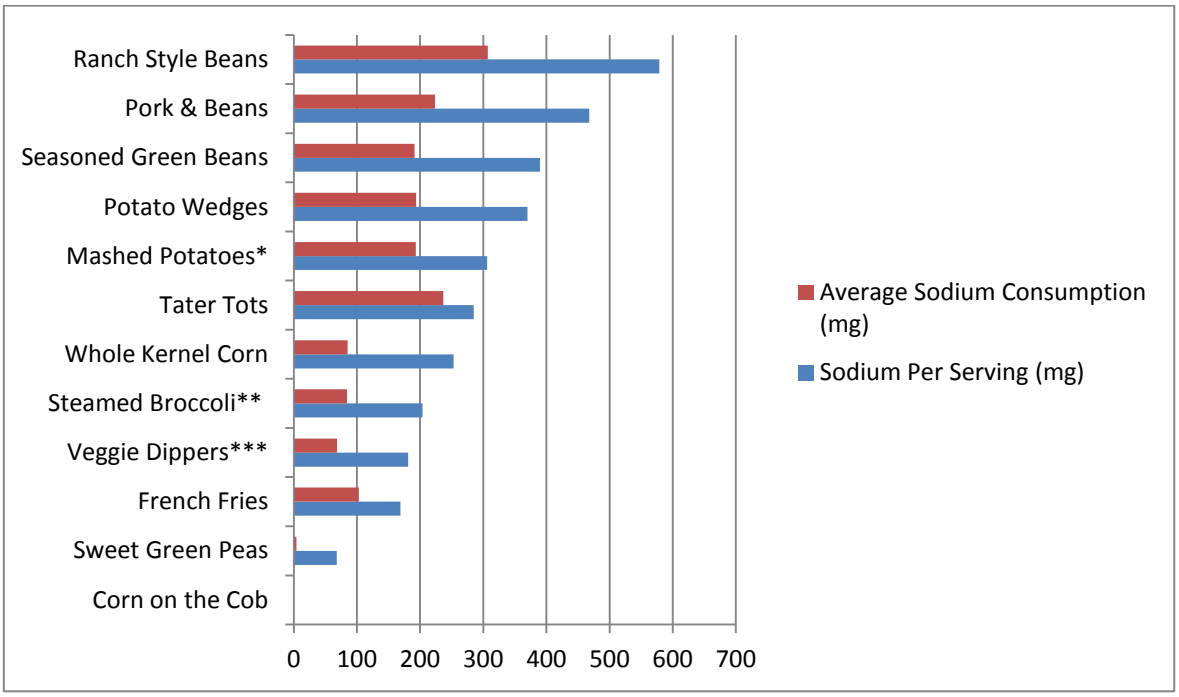
7.2 Objective IA

The sodium content of the pairings analyzed in the first objective was calculated. Table 15 contains information on the sodium content and actual consumption for each vegetable as well as for the pairing of the vegetable and entrée.

Table 15. Sodium Content and Mean Consumption from Vegetables

Vegetable	**Sodium Per Serving (mg)**	**Average Sodium Consumption (mg)**
Corn on the Cob	0	0
Sweet Green Peas	68	4.31
Veggie Dippers (with ranch dressing)	181	68.47
Steamed Broccoli (with cheese sauce)	204	83.99
Whole Kernel Corn	253	85.34
French Fries	169	103.05
Seasoned Green Beans	390	191.09
Mashed Potatoes (with gravy)	306	192.91
Potato Wedges	370	193.66
Pork & Beans	468	223.49
Tater Tots	285	236.76
Ranch Style Beans	579	307.08

Figure 10. Sodium Content and Mean Consumption from Vegetables



*Served with gravy
**Served with cheese sauce
*** Served with ranch dressing

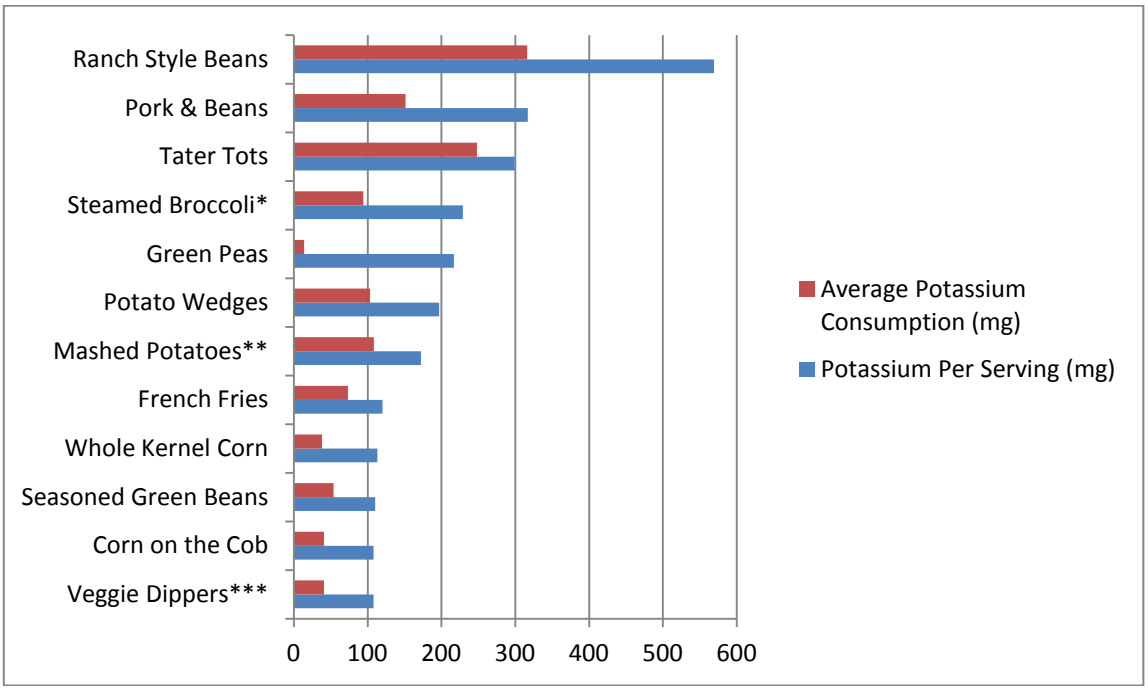
As shown in Figure 10, Corn on the Cob and Sweet Green Peas are associated with the lowest average consumption of sodium. Tater Tots, Pork & Beans, and Ranch Style Beans are all associated with an average consumption of over 200 mg of sodium.

Potassium content and actual consumption for each vegetable are described in Table 16 and Figure 11.

Table 16. Potassium Content and Mean Consumption from Vegetables

Vegetable	Potassium Per Serving (mg)	Average Potassium Consumption (mg)
Green Peas	217	13.76
Whole Kernel Corn	113	38.11
Corn on the Cob	108	40.69
Veggie Dippers	108	40.86
Seasoned Green Beans	110	53.90
French Fries	120	73.18
Steamed Broccoli	229	94.28
Potato Wedges	197	103.11
Mashed Potatoes w/ gravy	172	108.43
Pork & Beans	317	151.37
Tater Tots	299	248.17
Ranch Style Beans	569	316.12

Figure 11. Potassium Content and Mean Consumption from Vegetables



*Served with cheese sauce
**Served with gravy
***Served with ranch dressing

The USDA Nutrient Database was used for data on potassium content of the items. Data was not available for the entrée items, only vegetables.[53]

As shown in Figure 11, Tater Tots, Pork & Beans, and Ranch Style Beans are associated with the highest intake of potassium. Steamed Broccoli and Green Peas both provide over 200 milligrams of potassium but have a high average amount of waste leading to potassium consumption of less than 100 milligrams.

Table 17. Pairing and Associated Mean Sodium Intake

Vegetable (Entrée Pairing)	Average Sodium Intake (mg)
Mashed Potatoes (Pepperoni Hot Pocket)	323.79
Green Beans (Pepperoni Hot Pocket)	329.85
Veggie Dippers (Whole Baked Potato)	367.3
Potato Wedges (Grilled Chicken Sandwich)	404.97
Whole Kernel Corn (Whole Baked Potato)	459.43
Green Peas (Ravioli)	464.16
Corn on the Cob (BBQ on a Bun)	482.2
French Fries (Hamburger)	502.72
Corn on the Cob (Cheese Pizza)	523.67
French Fries (Toasted Ham & Cheese Sandwich)	550.27
Veggie Dippers (Ravioli)	550.89
Green Peas (Cheese Pizza)	551.32
Tater Tots (Beef & Bean Burrito)	589.25
Green Beans (Chicken Nuggets)	604.9
Tater Tots (Hamburger)	606.13
Mashed Potatoes (Chicken Nuggets)	615.49
Veggie Dippers (Cheese Pizza)	617.42
Potato Wedges (Hamburger)	630.24
Whole Kernel Corn (Cheese Pizza)	638.61

Table 17. Continued

Vegetable (Entrée Pairing)	Average Sodium Intake (mg)
Ranch Style Beans (Breaded Chicken Sandwich)	682.42
Pork & Beans (Breaded Chicken Sandwich)	688.57
Veggie Dippers (Steak Fingers)	725.6
French Fries (Pizza Sandwich)	727.84
French Fries (Hot Dog)	734.39
Steamed Broccoli w/ cheese sauce (Steak Fingers)	747.1
Mashed Potatoes (Crispy Steak Fingers)	805.7
Ranch Style Beans (Cheeseburger)	862.46
Green Beans (Crispy Steak Fingers)	881.11
Veggie Dippers (Deli Wrap)	959.5
Steamed Broccoli w/ cheese sauce (Deli Wrap)	981.26
Corn on the Cob (Ham & Cheese Hot Pocket)	1051.49
Mashed Potatoes (Munchables)	1235.95
Whole Kernel Corn (Mini Chef Salad)	1286.43
Veggie Dippers (Mini Chef Salad)	1301.97

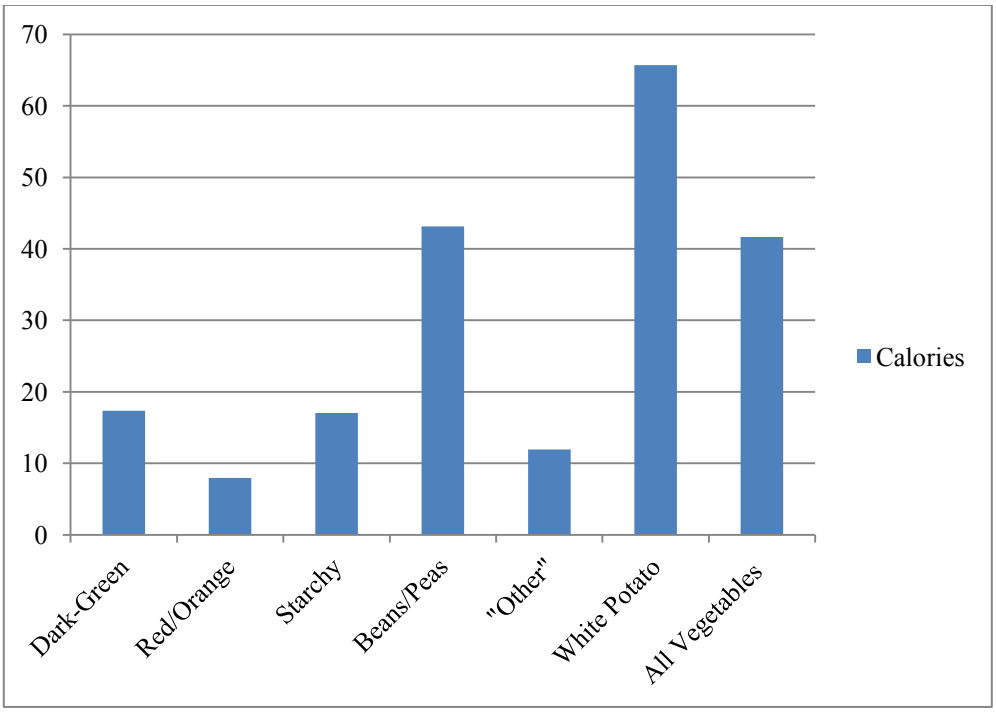
Table 17 analyzes the entrée and vegetable served at that lunch and does not include the fruit or milk item. This table analyzes consumption, therefore the amount of total sodium present is higher than the numbers presented above. Only thirteen of the

thirty-four pairings shown in Table 17 met the recommendation for less than 600 mg of sodium in the school lunch.

7.3 Objective II

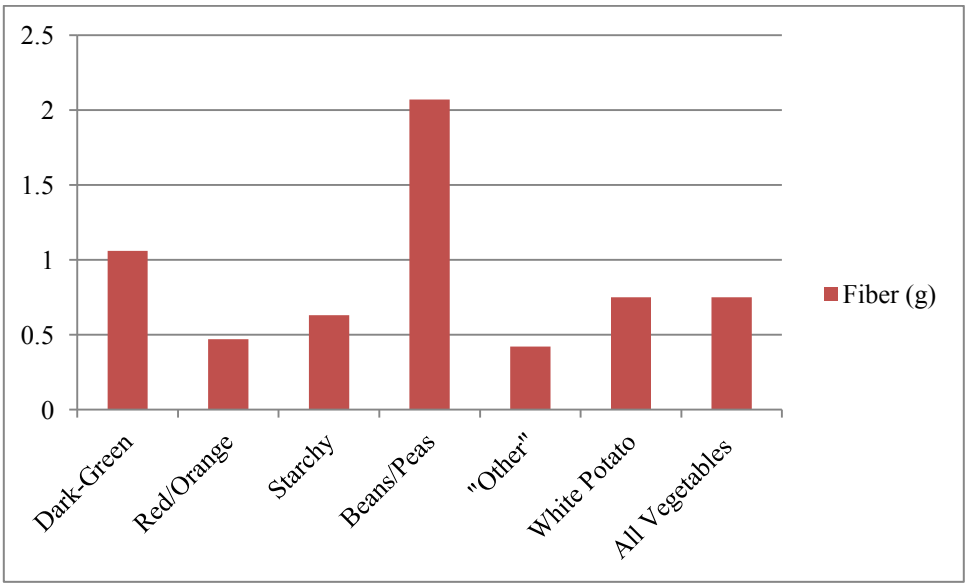
Calories, fiber, and calcium provided by each group of vegetables were analyzed. Fiber and calcium are both considered to be "short-fall" nutrients in the diets of elementary-school aged children.

Figure 12. Mean Calories Consumed from Each Vegetable Group



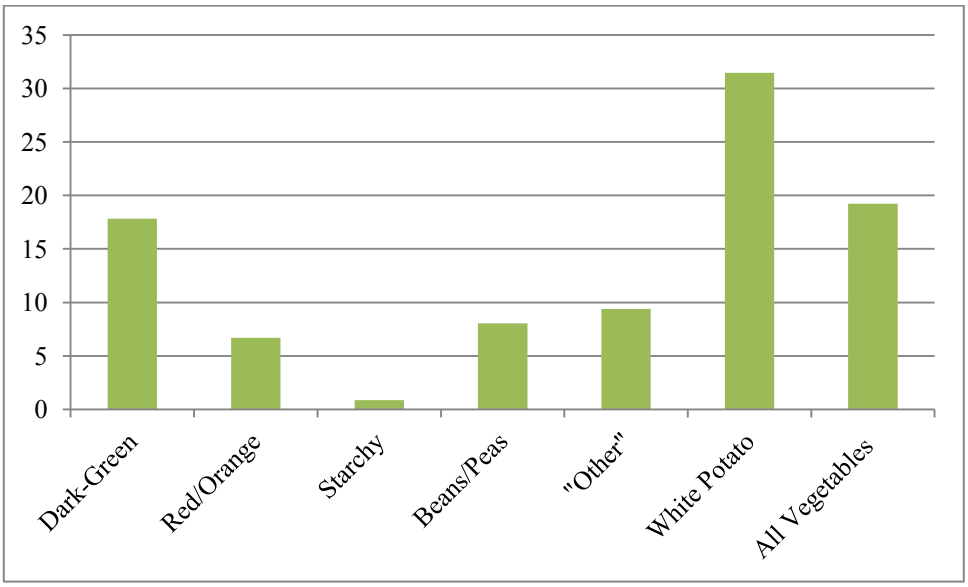
As shown in Figure 12, white potatoes on average provide the most calories of all of the vegetable groups when looking at actual consumption. They provide 65.7 calories per serving. Beans and peas provide the second largest amount of calories per serving at an average of 43.14 calories.

Figure 13. Mean Fiber Consumed From Each Vegetable Group



As shown in Figure 13, the fiber consumed from beans and peas provide largest amount of fiber of all of the vegetable groups. Dark-green vegetable were associated with the second largest consumption of fiber at 1.06 grams per serving. White potatoes were associated with an average consumption of 0.75 grams per serving.

Figure 14. Mean Calcium Consumed From Each Vegetable Group

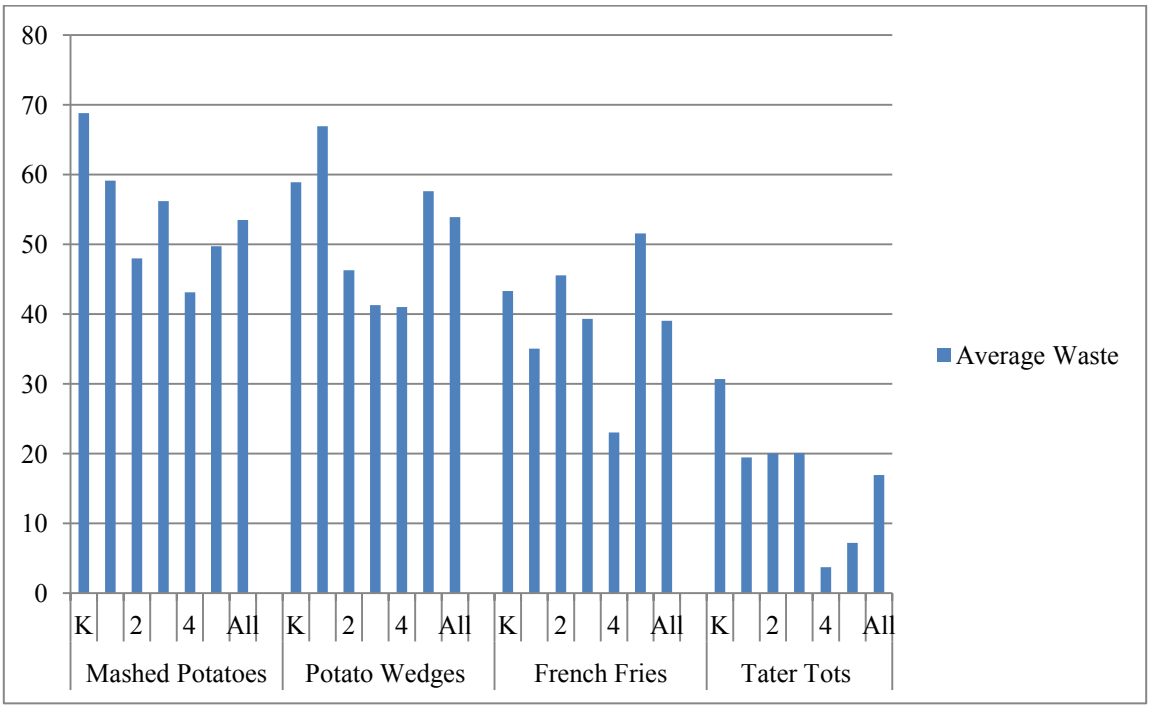


As shown in Figure 14, calcium is considered a “short-fall” nutrient in the diets of elementary school children. Consumption is generally low for this mineral. White potatoes are associated with the highest average consumption of calcium at 31.45 mg per serving. Dark-green vegetables are associated with the second highest consumption of calcium at 17.83 mg per serving.

7.4 Objective IIA

The average waste for each potato product was calculated for each grade and was also averaged for all elementary-school children as shown in Figure 15.

Figure 15. Mean Waste Percentage of Each Potato Product



The average waste of potato products was lowest for tater tots. Mashed potatoes and potato wedges had higher average waste than French fries and tater tots. Kindergarten and first grade students tended to have higher averages of waste than children that in the fourth and fifth grade.

8. DISCUSSION

High levels of waste were expected with the elementary school lunches but these levels are an issue that must be changed. With waste of food, goes loss of nutrient intake. The nutritional goals set for the NSLP cannot be met with the large amount of waste that occurs. School lunches have the potential to be nutritious meals, as long as waste is minimal. Although waste is high, there are issues such as excessive sodium intake. Potato products could potentially assist with this issue as they are naturally low in sodium, and if prepared in an acceptable manner with little to no added sodium, this product could be a method for reducing sodium intake. Tater tots are associated with the least waste among potato products, but it would be ideal to decrease the amount of sodium in this product.

The pairing of entrée and vegetable seemed to have an influence on intake of the vegetable. About 28% of broccoli was wasted when paired with the ham and cheese hot pocket whereas almost 100% of broccoli was wasted when paired with a corn dog. Mashed potato waste was least with the Munchables (cheese, ham, and crackers) but when thinking of natural pairings for mashed potatoes, it seems that crispy steak fingers or chicken nuggets would have the least. French fries were a popular item with waste less than 50% for each item that it was served with, but this was expected for this item. When served with a hamburger, French fries were wasted the least at 32%. This data makes sense, seeing that hamburgers are often served with French fries in other settings. Overall, green peas had an average waste of 75% and higher with no remarkable

differences between entrees. Vegetables such as green peas, broccoli, and green beans had higher average waste than French fries and tater tots. It is hypothesized that this could occur because French fries and tater tots are "finger foods" which leads to easier consumption compared to items that require utensils. Pearson found that children's intake of vegetables directly correlates with the parental intake of vegetables and this could explain vegetable intake in the children.[43] Intake for certain vegetables could be low due to low exposure to these vegetables at home. Also, some vegetables may have a more bitter taste to the children such as broccoli, and it has been found that bitterness greatly effects intake.[48] Often times the vegetable intake was less than fifty percent. Our study was not the only study that found high amounts of vegetable waste. Byker found that 51.4% of vegetable items and 51% of the entrée were wasted on average.[17] Some methods for changing this could be repeated taste exposure. Lakkakula found that eight or nine taste exposures changed the child's perception of the vegetable to "liking" or "liking a lot". This method would require that parents provide repeated taste exposures at home or the schools provide these taste exposures.

For some pairings the associations were obvious but for others they were not. For certain pairings such as hamburgers and French fries, hamburgers and potatoes wedges, and chicken nuggets and mashed potatoes, consumption was higher. It is hypothesized that consumption is higher for these items because these are items the children have been exposed to most inside and outside school. Also these items are often served together, creating a more "natural" pairing. More research is needed in the area to confirm these associations.

Average sodium consumption from vegetables was highest for ranch style beans, followed by tater tots and then pork & beans. Of the potato products, tater tots had the least waste and therefore the greatest sodium intake. With a preparation method that includes less sodium, tater tots have the potential to provide a nutritious option for children that is not highly wasted. The five items with the least amount of sodium per serving are corn on the cob, sweet green peas, French fries, veggie dippers, and steamed broccoli. Of these five items only French fries have consumption over 50%. These low sodium options have the potential to be ideal options if consumption can be increased. If children are not consuming these items, it removes the value of them being low in sodium.

There were four different pairings of vegetable and entrée that were associated with an average intake of more than 1000 milligrams of sodium. These pairings include: munchables with mashed potatoes, mini chef salad with veggie dippers, mini chef salad with whole kernel corn, and ham and cheese hot pocket with corn on the cob. The majority of the sodium came from the mini chef salad in two of the pairings. This salad contains many high sodium items such as ham, bacon, and cheese. These items only provide a portion of the student's daily sodium intake therefore it is concerning that only two items from their lunches provide that amount of sodium. The AI for children between the ages of nine and thirteen is 1.5 grams per day[21] yet these children are consuming nearly 1 gram with the school lunch. As seen in Table ???, when items other than the entrée and vegetable are added in, potential consumption of sodium is over 1000 milligrams for six of the ten top entrée and vegetable pairings. Of the four pairings

providing less than 1000 milligrams, the lowest sodium amount provided was 887 milligrams.

Figure 16 is from *Understanding Food Science and Technology.*[54] A high risk, low benefit would equate to dangerous whereas a low risk, high benefit would be ideal. For my thesis I have adapted the Risk vs. Benefit Analysis chart.

Figure 16. Risk vs. Benefit Analysis[54]

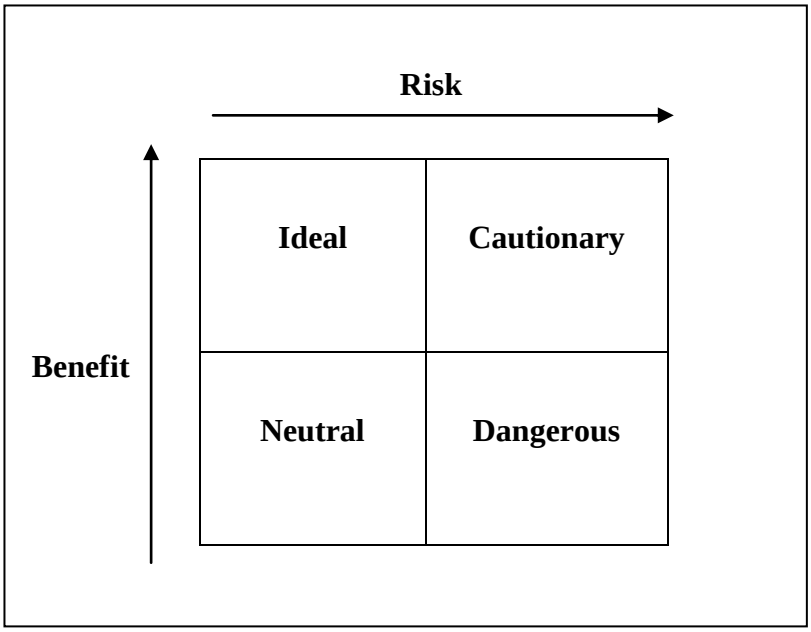


Figure 17 uses risk and benefit to label the food pairings as A, B, C, or D. Low risk, high benefit is A. High risk, high benefit is B. Low risk, low benefit is C. High risk, low benefit is D. The two items that will be compared are sodium as a risk and fiber as a benefit. For risk, if sodium consumption was higher than 640 milligrams for the pairing, it fell into the B category, but if it was below 640 milligrams for the pairing it fell into

the A category. The "ideal" amount of sodium was considered below 640 milligrams because of the future NSLP recommendations that school meals contain less than 640 milligrams of sodium.[4,5] On the benefit portion, if fiber met the recommendation of 14 grams per 1000 calories for the pairing, it fell into the A category, but if fiber was below the recommended 14 grams per 1000 calories for the pairing, it fell into the C category.

Figure 17. Risk vs. Benefit Analysis for Sodium and Fiber

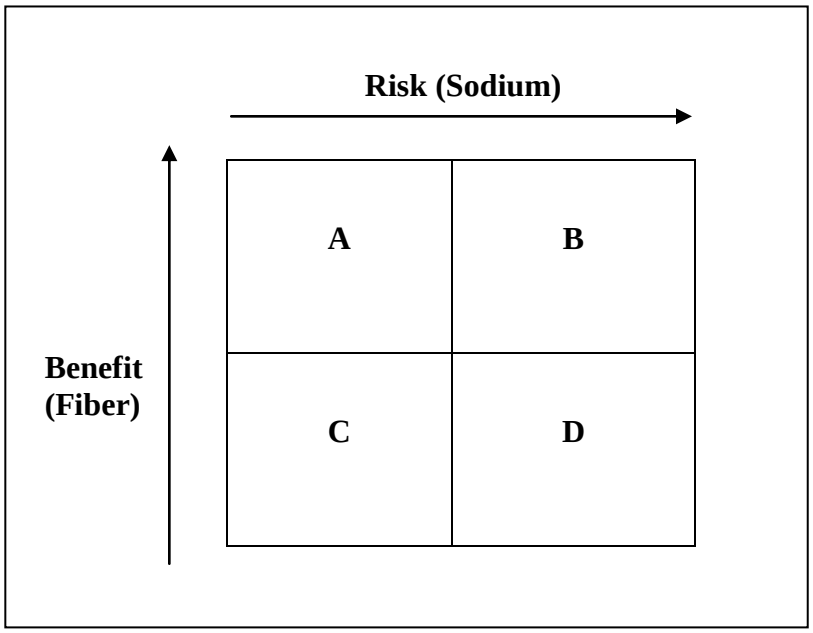


Table 18. Risk Benefit Analysis

Pairing	Sodium (mg)	Fiber (g)	Category
Ham and Cheese Hot Pocket with Broccoli	1493	4.5 (7.2)*	D
Munchables with Mashed Potatoes	1555	17 (4.6)*	B
Cheeseburger with French Fries	1054	4.4 (5.8)*	D
Hot Dog with French Fries	919	2.4 (4.8)*	D
Whole Baked Potato with Whole Kernel Corn	1061	8.2 (6.7)*	B
Crispy Steak Fingers with Green Beans	1230	3.5 (4.6)*	D
BBQ on a Bun with Corn on the Cob	788	5.3 (5.6)*	D
Chicken Tenders with Mashed Potatoes	654	3.3 (4.4)*	D
Chicken Tender Wrap with Corn on the Cob	504	4.3 (4.3)*	A
Corn Dog with Corn on the Cob	740	3 (5.0)*	D

*Indicates the equivalent amount of sodium to meet recommendation of 14 grams of fiber per 1000 calories.

Table 18 describes the Risk Benefit Analysis. Of the top ten pairings, only one pairing fell into the A category (low sodium, high fiber). The chicken tender wrap with corn on the cob provided less than 640 milligrams of sodium and a sufficient amount of

fiber. Two pairings were labeled B (high sodium, high fiber) because they provided enough fiber to classify them as "beneficial". The other seven pairings were classified as D (high sodium, low fiber) due to excessive sodium and inadequate fiber. This risk versus benefit analysis shows the varying levels of sodium and fiber within the school lunches. It would be beneficial to consume items high in sodium and low in fiber in moderation.

Each vegetable was analyzed for sodium and potassium content without the entrée. Pork & beans, ranch style beans, and tater tots have three of the highest average intakes of both sodium and potassium. High potassium consumption is desired, but the sodium consumption should be decreased. If these items were prepared in a way that involved less sodium, they would be an ideal vegetable option for school lunches.

White potatoes provide the highest amount of calories at an average of 65.7 calories per serving. With an increase in childhood obesity, the high intake of calories from white potatoes could be seen as a problem. Fiber, a short-fall nutrient in elementary school children, was consumed in the highest amount from beans and peas at an average of 2.07 grams per serving. White potatoes are associated with an average consumption of 0.75 grams of fiber per serving. Potatoes are associated with the highest amount of calcium consumption of the vegetable groups with an average of 31.45 milligrams consumed. While white potatoes are associated with the highest calcium consumption, 31.45 milligrams is a minuscule amount of the recommended 1000 milligrams for children ages four to eight and 1300 milligrams for children ages nine to thirteen.[22] No more than an average of 54% of the potato item was wasted when served, whereas many

other vegetable items had an average waste of up to 80%. Children enjoy potato products and receive key shortfall nutrients from them such as fiber and calcium, but they also provide too much sodium and calories.

When comparing the average waste of the different potato products, it was found that French fries and tater tots had less waste than mashed potatoes. It is hypothesized that this could be due to French fries and tater tots being “finger-foods”, which smaller children consume more easily than foods that require utensils. It was also observed within the potato waste that kindergarten and first grade students tended to have higher amounts of waste than the fourth and fifth grade students. This could be due to increased appetites in older children due to their larger size. The same serving size is used for every grade even though the kindergarten students are much smaller and often consume less.

9. CONCLUSIONS

The National School Lunch Program serves to provide guidance to school foodservice to promote healthy eating behaviors in school children. Such behaviors can be carried into adulthood, and are essential for the prevention of many nutrition-related diseases. The provision of well-balanced meals providing opportunities for the consumption of key nutrients such as fiber, calcium, and potassium while limiting the consumption of excessive calories and sodium is essential. With guidelines set to reduce sodium in school lunches, menu items need to be evaluated for their sodium content. Our study only examined one meal of the day: lunch. School children would have the potential to consume more foods at other meals, and also might engage in snacking behaviors between meals. As seen in this study's entrée and vegetable pairing results, many of the entrée and vegetable pairings far exceed 1000 milligrams of sodium for the school meal alone.

A unique aspect of this research was to examine entrée and vegetable pairings, since appropriate combinations of entrée and vegetable might lead to decreased food waste. We even categorized ten such pairings not only with respect to waste, but examined "risk-benefit", in which "risk" was related to increased sodium content while "benefit" was with respect to increased fiber content. Only one pairing fell into what we categorized as the "A" group (low sodium, high fiber). The chicken tender wrap with corn on the cob provided less than 640 milligrams of sodium and a sufficient amount of fiber, and in this regard, surpassed all of the other pairings.

Decreased waste in school settings might be due to sensory appeal or previous exposure to the specific foods, but it is currently an area needing examination. In this study, it was determined that there is an association between entrée and vegetable pairing. It is also important to confirm to the amount of sodium that is provided within each of these pairings to ensure that they meet the guidelines for school lunches in the future.

It is possible that for many school children, favorite meats, vegetables, fruits, and other foods might serve as "gateway" food items for other foods within those categories. As an example, potato products are favored by school children, and might serve to aid in the introduction and acceptance of new or different vegetables into meals, which might reduce waste compared to introducing the new vegetable alone. In our study, mean waste of vegetables was least for the potato products. Potato products are interesting to study, because depending upon the manner of preparation (for example, baked potato in the skin vs. French fries), they may provide essential nutrients such as fiber and calcium, but potentially also high amounts of sodium and fat.

As already alluded to, this study was not without limitations. Rather than consider every possible nutrient of importance to child health, the study purposely focused only on calories, fiber, potassium and sodium. In the "risk-benefit" section, we only considered sodium and fiber. Clearly there are many other food components (cholesterol, fat, vitamins, minerals) that would truly contribute to these two categories. It was not possible to control the numbers of children who chose to eat at school versus those who brought a lunch from home. This meant that this characteristic of the studied

population had the potential to change each data collection day, which could generate variability in the data. The research team also had no control over the food served and the dates the collections occurred, which were decisions made by each individual school. As an example again with respect to potatoes, baked potatoes were not menu items in the school meals examined. There are also many potential outside influences that potentially affect intake of school lunches that the researcher was unable to control for, including peer pressure/peer influence, exposure to certain foods in their home, and by the timing of physical education class in relation to lunch.

Based upon the results of this study, and recognizing the limitations mentioned, it may be prudent for school foodservice to consider entrée/vegetable pairings when confronting the issue of nutrients consumed vs. wasted by school children. Additionally, certain pairings may lead to less plate waste and greater overall food and nutrient consumption, while providing less sodium. The use of the popular vegetable the potato - especially when prepared in such a manner to provide fiber and other key nutrients - may help decrease waste and improve nutrition when served in school meals. As stated at the outset of this thesis, healthy eating is an important factor in contributing to health and disease prevention in children. Foodservice options to decrease waste and sodium in elementary school lunches, as well as increase overall food consumption as well as calories, fiber, potassium, and calcium, can help achieve the goal of achieving child health

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APPENDIX

Description of Vegetables

Vegetable	**Description**	**Serving Size**
Mashed Potatoes	Served with gravy	½ cup potato, 1 oz gravy
Green Beans	Seasoned	½ cup
Pork & Beans		½ cup
Veggie Dippers	Approximately 4 carrot slices Approximately 4 celery slices Served with ranch dressing	½ cup
Whole Kernel Corn		½ cup
French Fries	Baked	½ cup
Green Peas	Sweet green peas	½ cup
Corn on the Cob	Cob	1 cobbette
Broccoli	Served with cheese sauce	½ cup
Tater Tots	Baked	½ cup
Ranch Style Beans		½ cup
Potato Wedges	Baked	½ cup

Nutrient Profile for Vegetables

Vegetable	Serving Size	Calories	Fiber (g)	Potassium (mg)	Calcium (mg)
Mashed Potatoes w/ gravy	½ cup potato 1 oz gravy	97	1	172	18
Seasoned Green Beans	½ cup	17	1.5	110	28
Pork & Beans	½ cup	132	9.2	317	67
Veggie Dippers	½ cup	64	1.4	108	45
Corn on the Cob	1 cobbette	90	2.0	108	2
Whole Kernel Corn	½ cup	78	2.0	113	3
French Fries	½ cup	102	1.4	120	9
Potato Wedges	½ cup	146	2.9	197	18
Green Peas	½ cup	74	5.2	217	27
Steamed Broccoli w/ cheese sauce	½ cup	74	2.3	229	97
Tater Tots	½ cup	142	1.7	299	17
Ranch Style Beans	½ cup	128	5.9	569	39